EXHIBIT A

LSI LOGIC - INVENTION DISCLOSURE FORM

COPY

Disclosure No. 99-222

1. INVENTOR(S)

A. NAME: Ning Xue M/S - G815 EXT: 64341

HOME ADDRESS: [redacted] HOME PHONE: [redacted]

CITIZENSHIP: P.R. China

B. NAME: Darren Newman M/S - G-815 EXT: 648516

HOME ADDRESS: [redacted] HOME PHONE: [redacted]

CITIZENSHIP: USA

C. DIVISION, DEPARTMENT, SUBSIDIARY Consumer products division

2. TITLE OF THE INVENTION (MUST BE FILLED OUT): antiblock noise filter: a method to remove block related artifacts in video

3. CONCEPTION OF THE INVENTION

A. DATE OF FIRST DRAWING [redacted]

WHERE CAN FIRST DRAWING BE FOUND? notebook

B. DATE OF FIRST WRITTEN DESCRIPTION [redacted]

WHERE IS DESCRIPTION FOUND? presentation documen

C. DATE OF FIRST ORAL DISCLOSURE TO OTHERS [redacted]

TO WHOM? 022 design team

COPY

RECEIVED

SEP 07 1999

LSI LOGIC CORP.
INTELLECTUAL PROPERTY DEPT.

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4. CONSTRUCTION OF DEVICE

A. DATE COMPLETED

B. WAS PROTOTYPE MADE?

C. BY WHOM MADE?

D. WHERE CAN PROTOTYPE BE FOUND?

5. TEST OF DEVICE

A. DATE July, 99

B. WITNESS

C. RESULT

6. SALE

A. WAS INVENTION SOLD? YES (NO)

B. DATE OF FIRST SALE

7. USE

A. IS THE INVENTION PRESENTLY BEING USED? (YES) NO

B. ARE THERE SPECIFIC PLANS FOR ITS USE IN THE NEAR FUTURE? YES NO

INVENTORS:

Ning Xue [redacted] DATE [redacted]

Darren Newman [redacted] DATE [redacted]

WITNESS, READ AND UNDERSTOOD BY:

(PRINT) Wen Huang (SIGN) [redacted] DATE [redacted]

(PRINT) Winnie Lau (SIGN) [redacted] DATE [redacted]

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8.	RELATED PRINTED PUBLICATIONS, PATENTS, PATENT APPLICATIONS.			
9.	WAS INVENTION			
	A.	CONCEIVED DURING PERFORMANCE OF GOVERNMENT CONTRACT?	YES	(NO)
	B.	CONSTRUCTED DURING PERFORMANCE OF GOVERNMENT CONTRACT?	YES	(NO)
	C.	TESTED DURING PERFORMANCE OF GOVERNMENT CONTRACT?	YES	(NO)
	D.	CONTRACT NUMBER	CONTRACT NUMBER	
10.	WAS INVENTION			
	A.	CONCEIVED DURING PERFORMANCE OF CUSTOMER CONTRACT?	YES	(NO)
	B.	CONSTRUCTED DURING PERFORMANCE OF CUSTOMER CONTRACT?	YES	(NO)
	C.	TESTED DURING PERFORMANCE OF CUSTOMER CONTRACT?	YES	(NO)
	D.	CUSTOMER NAME	CUSTOMER	

THIS DESCRIPTION OF THE INVENTION SHOULD BE WRITTEN IN THE INVENTOR'S OWN WORDS AND GENERALLY SHOULD FOLLOW THE OUTLINE GIVEN BELOW. SKETCHES, PRINTS, PHOTOS AND OTHER ILLUSTRATIONS, AS WELL AS REPORTS OF ANY NATURE IN WHICH THE INVENTION IS REFERRED TO, IF AVAILABLE, SHOULD FORM A PART OF THIS DISCLOSURE AND REFERENCE CAN BE MADE THERETO IN THE DESCRIPTION OF CONSTRUCTION AND OPERATION.

USE THE ATTACHED SHEETS TO ANSWER THE FOLLOWING QUESTIONS.
(Attach Engineering Reports or other documentation to this form.)

1.	GENERAL PURPOSE OF THE INVENTION. STATE IN GENERAL TERMS THE OBJECTS OF THE INVENTION.
2.	DESCRIBE OLD METHOD(S), IF ANY, OF PERFORMING THE FUNCTION OF THE INVENTION.
3.	INDICATE THE DISADVANTAGES OF THE OLD METHOD(S).
4.	DESCRIBE THE CONSTRUCTION OF YOUR INVENTION, SHOWING THE CHANGES, ADDITIONS AND IMPROVEMENTS OVER THE OLD METHOD.
5.	GIVE DETAILS OF THE OPERATION IF NOT ALREADY DESCRIBED UNDER 4.
6.	STATE THE ADVANTAGES OF YOUR INVENTION OVER WHAT HAS BEEN DONE BEFORE.
7.	INDICATE ANY ALTERNATE METHOD OF CONSTRUCTION.
8.	IF A JOINT INVENTION, INDICATE WHAT CONTRIBUTION WAS MADE BY EACH INVENTOR.
9.	FEATURES WHICH ARE BELIEVED TO BE NEW.
10.	STATE OPINION OF RELATIVE VALUE OF THE INVENTION.
11.	AFTER THE DISCLOSURE IS PREPARED, IT SHOULD BE SIGNED BY THE INVENTOR(S) AND THEN READ AND SIGNED BY TWO WITNESSES IN THE SPACE PROVIDED AT THE BOTTOM OF EACH SHEET.

INVENTORS:

Ning Xue — DATE [redacted]

Darren Newman — DATE [redacted]

WITNESS, READ AND UNDERSTOOD BY:

(PRINT) Wen Huang (SIGN) — DATE [redacted]

(PRINT) Winnie Lau (SIGN) — DATE [redacted]

LSI LOGIC [redacted]

Anti-block noise Filter: algorithm and implementation

1.0 Purpose of Development

To encode a MPEG bitstream, the whole picture is sliced into small microblocks, which are transformed into frequency domain and quantized.

The encoding procedures are carried over by hardware or software encoders. Some of encoders are real-time running thus constrained by its bandwidth. That is to say, if the encoder, either hardware encoder or other hardware like CPUs that carry over the software encoding task, can only encode the number of bits that the hardware is capable to. When the encoding resources contains quick motion, or too little bandwidth is allocated to the left image because of bad bandwidth allocation, or the hardware is in portable devices with limited power supply thus cannot run at full speed to avoid eating up all the power, encoders usually provide lower bandwidth on bits representing flat regions and non-motion background blocks. Usually the DC value has more priority in bandwidth allocation compared to higher frequency bits, but If the left bandwidth is too little, the DC quantization in the flat region or background blocks may not be encoded harshly. Therefore a decoder cannot reconstruct the decent DC values.

The bandwidth allocation is dynamic and varies from block to block. A flat region usually cover a big region on display such as quarter size of the screen. If among these many flat microblocks, some DC values are quantized well, and others are not, the whole reconstructed picture looks blocky. This is always in the VCD images because its bandwidth is more limited compared to MPEG2 video. Real-time encoded MPEG2 video on camcorder or in TV home shopping have the same blocky microblocks because encoder must run at the real speed to process all the images.

A block noise filter is designed to reduce the harsh DC quantization impact in reconstruction.

2.0 Previous Methods

An old method is to collect DC values from all the microblocks in the picture and low pass them.

INVENTORS: [redacted] DATE:

WITNESSED, READ AND UNDERSTOOD BY:
(print) Wen Huang (sign) [redacted] DATE: [redacted]
(print) Winnie Lau (sign) [redacted] DATE:

3.0 Disadvantages of Old Methods

The old method violates the image reference defined in MPEG2 specification because the current image may be used as a reference for future images, so that any change in one image may be propagated to other images.

In addition, the old method is not adaptive. It requires the DC values from all microblocks, which demands a high bandwidth and usually is only possible in software decoding. Not all the microblocks should be treated the same.

4.0 Construction of New Method

Please refer to the attached document.

5.0 Details of Operation

please refer to the attached document.

6.0 Advantages of New Method

The new method only requires few microblock DC values, which is feasible in hardware. It is adaptive, only filtering the region where the blocky-ness is the most significant. and leave alone the original details in the active region untouched.

no alternate method Of construction to date.

7.0 Joint Venture Contribution

The complete idea was started from scratch. Darren Neuman contributed a lot in the concept and algorithm, Ning Xue built the lab test and collected the preliminary results, refined the algorithm and implemented the filter in hardware.

8.0 New Features

none.

INVENTORS: [redacted] [redacted] DATE:

WITNESSED, READ AND UNDERSTOOD BY:

(print) Wen Huang (sign) DATE: [redacted]

(print) Winnie Lau (sign) DATE: [redacted]

9.0 Relative Value of Invention

This invention is very valuable because it allow our product to outperform other sin the market and provide low-end encoded resource improved quality. It is practical and efficient. hardware sample test results are very positive. This feature can be very attractive in the DVD market like China and the real-time encoding market like portable camcorder.

INVENTORS: [redacted] [redacted] DATE:

WITNESSED, READ AND UNDERSTOOD BY:

(print) Wen Huang (sign) DATE:

(print) Winnie Law (sign) DATE: [redacted]

Anti-block noise filter design review

Ning Xue, [redacted]

Purpose of Development:

-- remove blocky artifacts in VCD titles and low-quality DVD titles like real-time encoded DVDs. This is to ensure flat background is not blocky during normal speed display and high quality of slow speed and freeze playback.

-- User can control the filter regarding to title encoding qualities by programming host registers. Luma anti-block filter and chroma anti-block filter can be enabled or disabled separately

-- anti block-noise filter should support all existing display controller features (display modes/horizontal filtering) provided on L64020/21 decoders.

Filtering Algorithm:

-- what should be filtered? block boundaries. In encoding, motion blocks allocate more bandwidth than background blocks (?)

-- Difficult to build a filter that filters all block boundaries without damaging picture details/high frequency components around block boundaries. --> which block boundary should be filtered?

-- human being eyes are sensitive to blocky artifacts in flat region, not activity/motion block.

-- How to detect a flat block? --> Variance of the block.

-- And how to filter the block boundary?

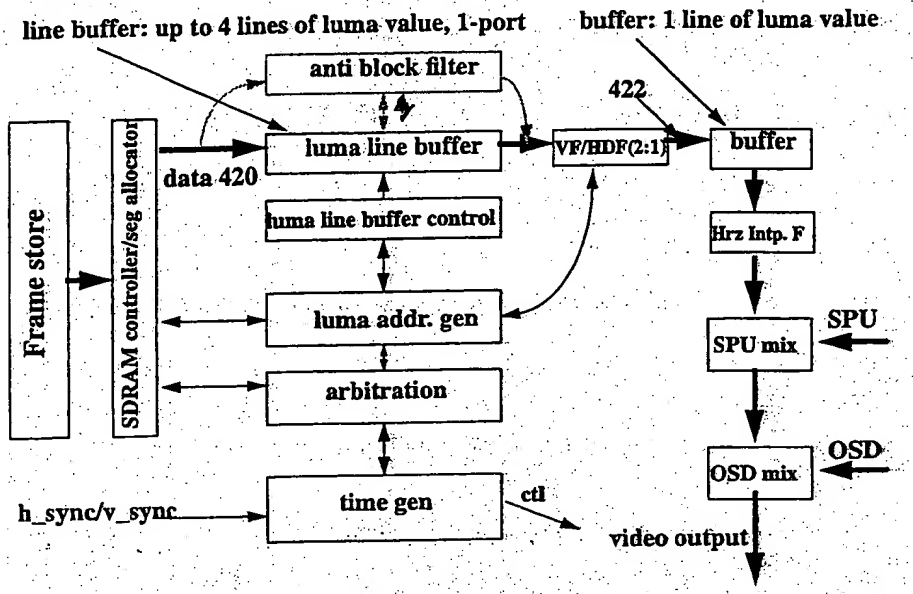
-- Horizontal and vertical

-- tap of a filter/phase shift

-- hardware limitation

Witnessed, read and understood by: [redacted]

--Display Controller block diagram (luma only)



Ning
3/12

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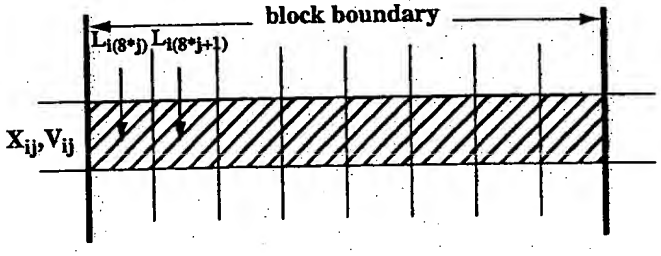
Modified filtering algorithm:

Partition an 720 x 480 image into 90 x 480 subblocks, each of which has 8 pixels in a row.



Let luma value of each pixel be Lij, and define Xij to be the average mean of the subblock and Vij be the average variance of the subblock, i.e.

$$Xij = 1/8 \sum_{k=0}^{k=7} Li(8*j+k) \qquad Vij = 1/8 \sum_{k=0}^{k=7} (Li(8*j+k) - Xij)^2$$

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4/12

witnessed, read and understood by [redacted]

Horizontal filtering:

-- Only pixels next to the vertical boundaries of a 8 x 8 block filtered. To filter columns further away from vertical boundaries, a bigger filter is a must.

-- Is line variance itself sufficient?

No, the dc offset condition should be monitored. It is checked to avoid anti block-noise filter blur character display on the screen. The characters carry little variance however sharp dc offset from the background.

-- line variance, line mean

-- tap-5/tap-3/tap-2(easier to implement?)

-- luma filter/chroma filter

[redacted] Ning

Vertical filtering:

-- hardware limitation: no vertical line mean or vertical line variance

-- store mean and variance of previous line + current line in the line buffer

For previous line data:

---- use subblock mean and variance only, store mean value and "variance < var_th" (true/false)

---- 2 lines of data --> only filter the top line in a block

For current line data:

---- access to current line buffer is a problem as line buffer is 1-port and has to service SDRAM controller and Vertical filter.

---- or to duplicate current line buffer, 8 words per read--> gate count

-- more rely on dc offset information.

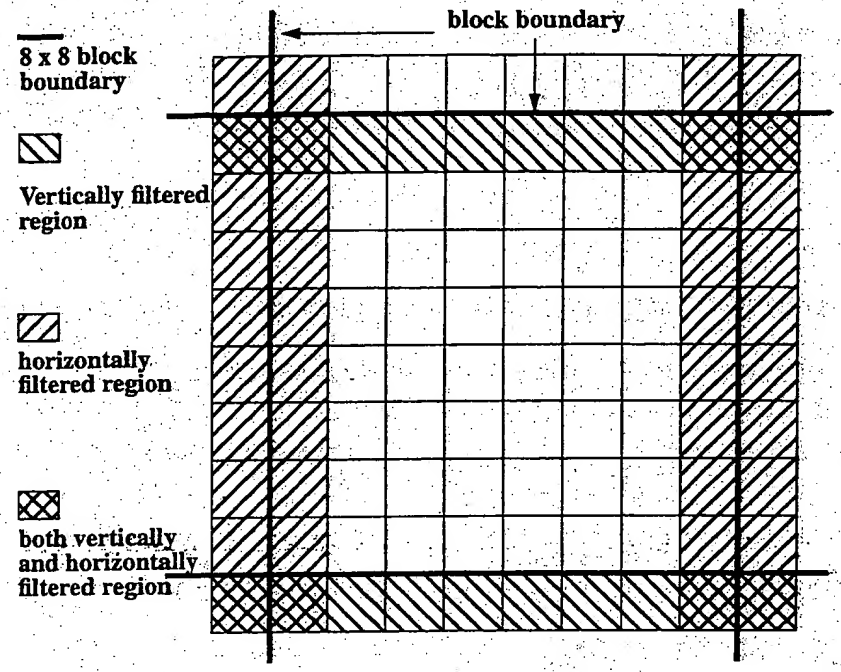
-- tap-3/tap-2

[redacted] Ning

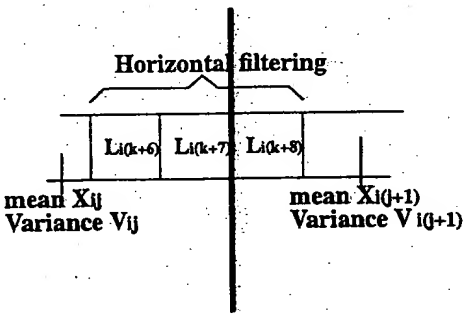
witnessed, read and understood by

Yihan Huang [redacted]

filter region (luma only)

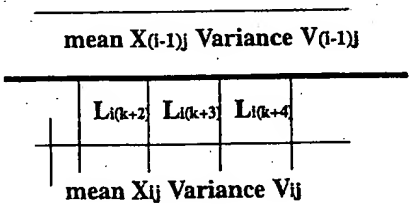


Ning



If $V_{ij} < Var\_th$ and $V_{i(j+1)} < var\_th$ and $abs(X_{ij} - X_{i(j+1)}) < mean\_th$

$\overline{L}_{i(k+7)} = 1/3\ (L_{i(k+6)} + L_{i(k+7)} + L_{i(k+8)})$



Vertical filtering

If $V_{(i-1)j} < Var\_th$ and $V_{ij} < Var\_th$ and $abs(X_{(i-1)j} - X_{ij}) < mean\_th$

$\overline{L}_{i(k+3)} = 1/2\ (mean_{(i-1)j} + L_{i(k+3)})$

Ning

witness, read and understood by:

How to compute variance?

-- computation intensive, each luma/chroma data is 1 byte long, the difference respect to subblock mean can be 9 bit-long

-- great amount of calculations, 1.5 square calculations/per pixel, 1 for luma, 2 * 0.25 for 2 chromas

-- no accurate variance calculation is required, piece-wise linear solution is acceptable

-- approximation of X^2:

Define $X = X_7X_6X_5X_4X_3X_2X_1X_0$

$X^2 \sim X_70X_60X_50X_40X_30X_20X_10X_00$

-- for negative X, convert to positive then use approximation or pad 1's, then take absolute value

-- when X is big, the square calculation can be ignored as the output is assumed out of threshold

[redacted] Ning 9/12

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Problems left:

1. The algorithm is not complicated. Has this been used?

2. Hardware implementation:

2.1 Anti-block filter support all display modes?

2.2 possible to insert anti-block filter while keeping timing?

2.3 to access line buffer data or duplicate it elsewhere? timing vs. gate count

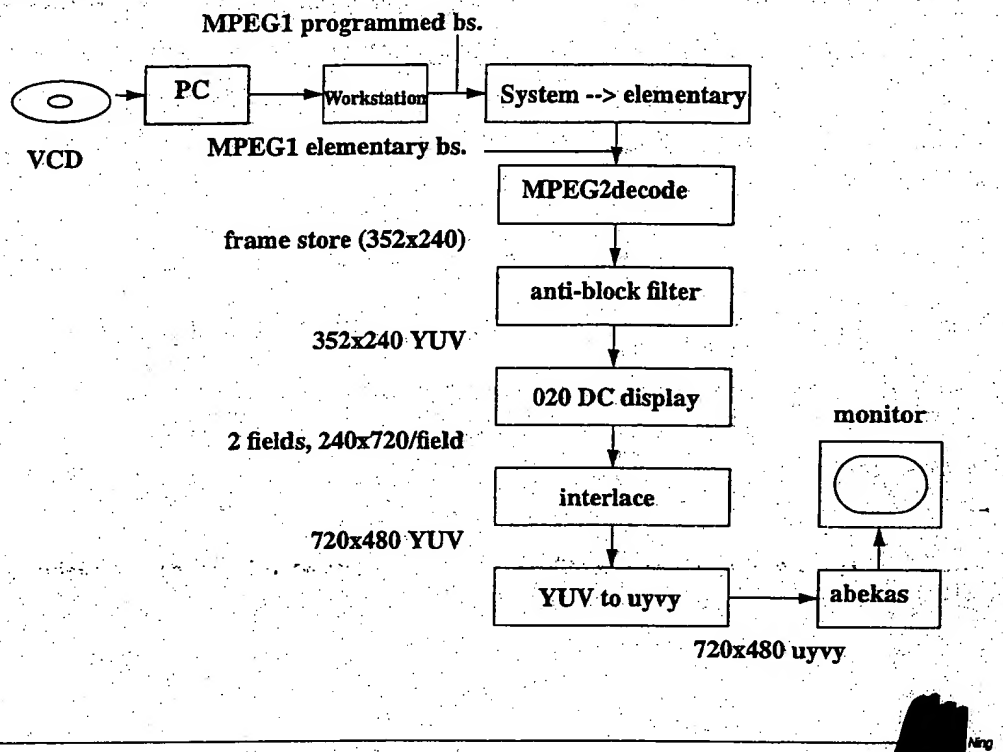
3 How does NTSC compared to digital betacam test equipment?

[redacted] Ning 10/12

witnessed, read and understood by

[redacted]

work flow:



[redacted] Ning 11/12

Source materials:

-- VCD titles: "Terminator II" (battle field, in the elevator), "007: Golden Finger" (card game)

1. battle field: laser beam, wheel of tank, sky background, skulls

2. in the elevator: wall of the elevator, terminator's jacket, human being faces

3. card game: human being hand, characters

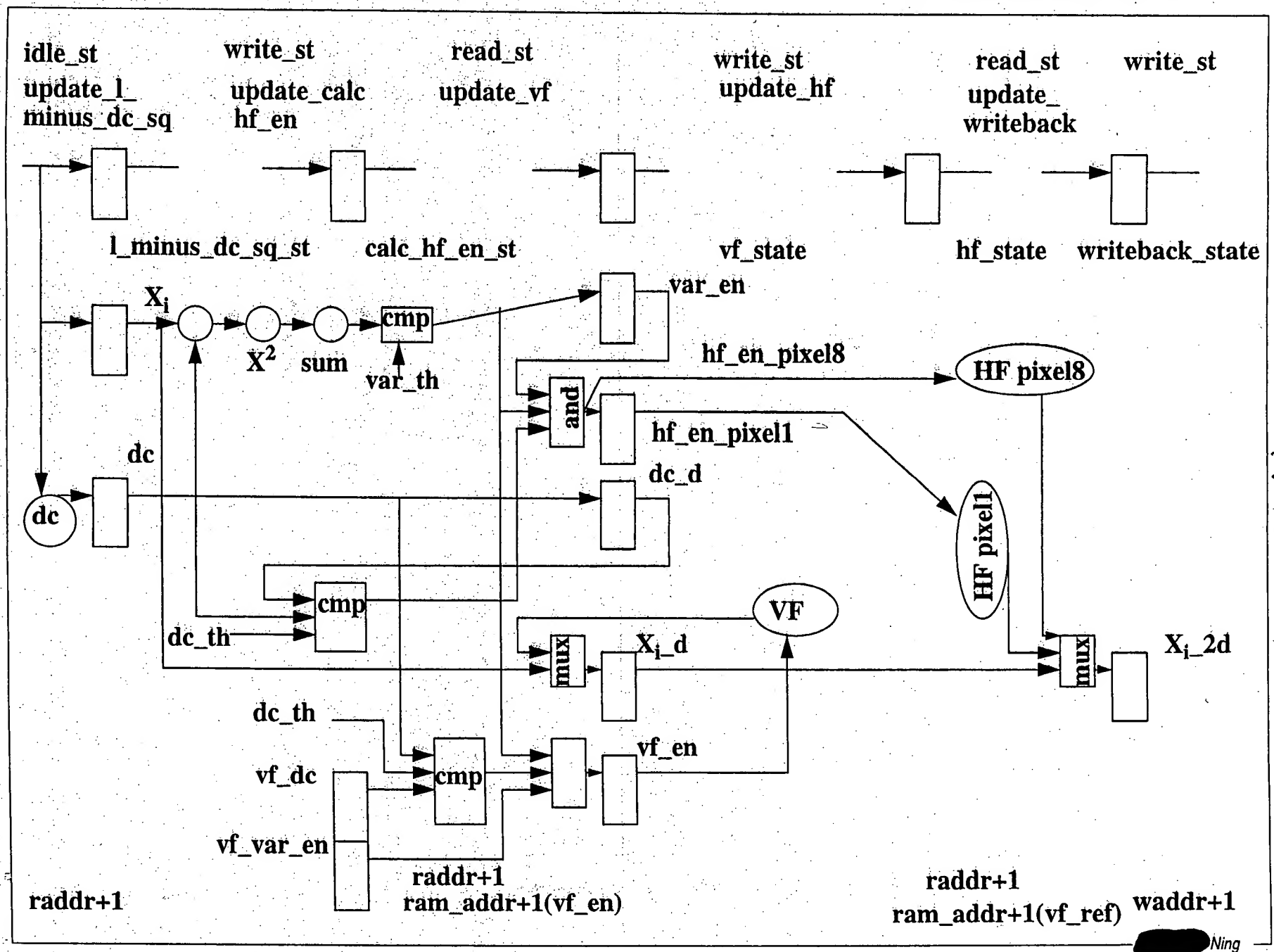
VCD/MPEG1 video: 352x240 --> 720x480, each block is scaled by 2 in each dimension

Video sequence displayed:

original video --> filtered video --> original frame vs. filtered frame --> 4 in 1 screen

[redacted] Ning 12/12

witnessed, read and understood by [redacted]

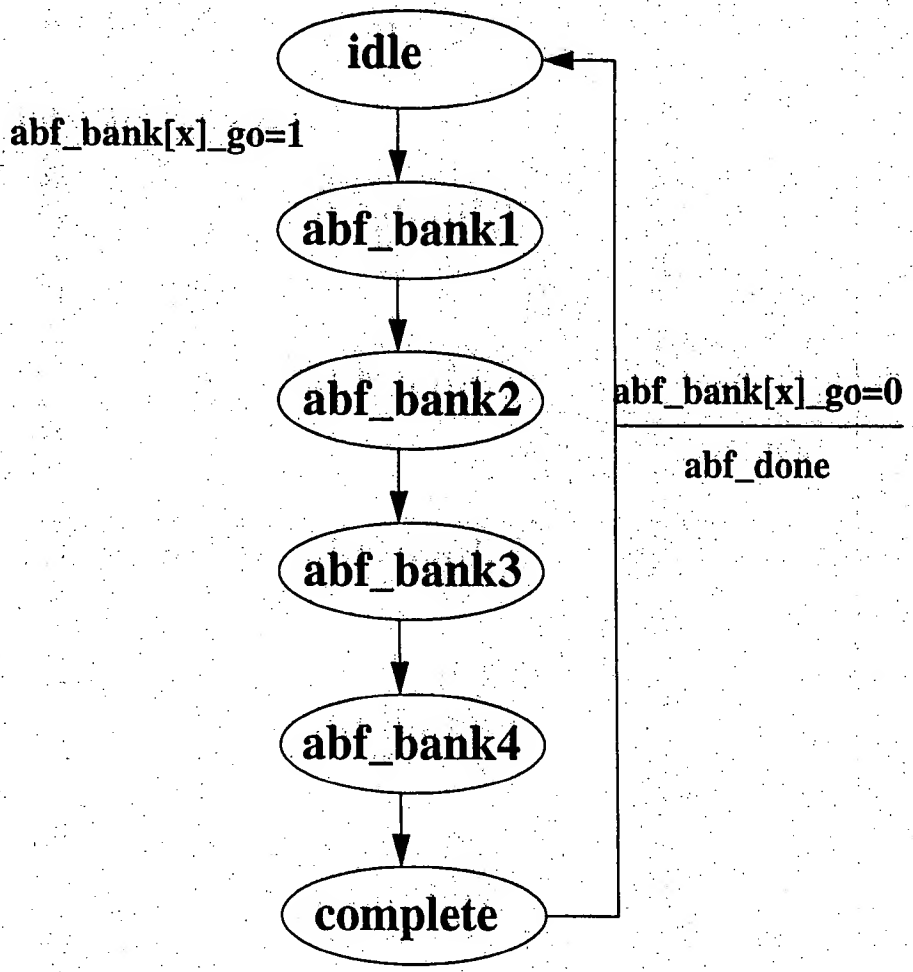


[redacted] Ning

witnessed, read and understood by [redacted]

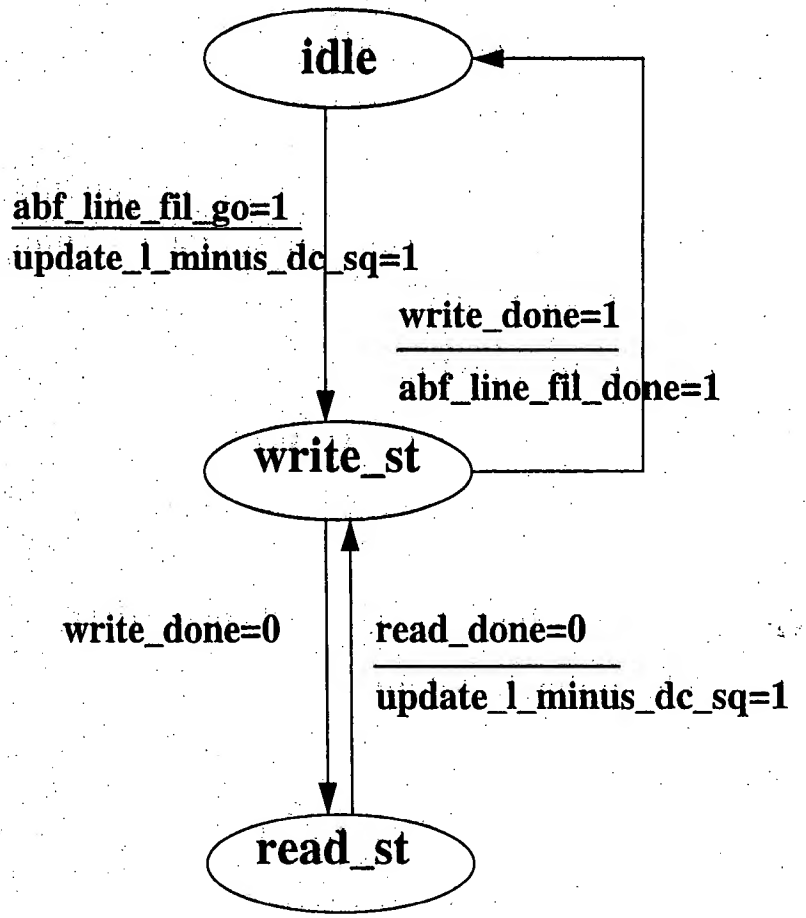
anti block noise filter control state machine

abf_ctl



anti block noise filter datapath state machine

abf_fil



[redacted] Ning

witnessed/read and understood by [redacted]